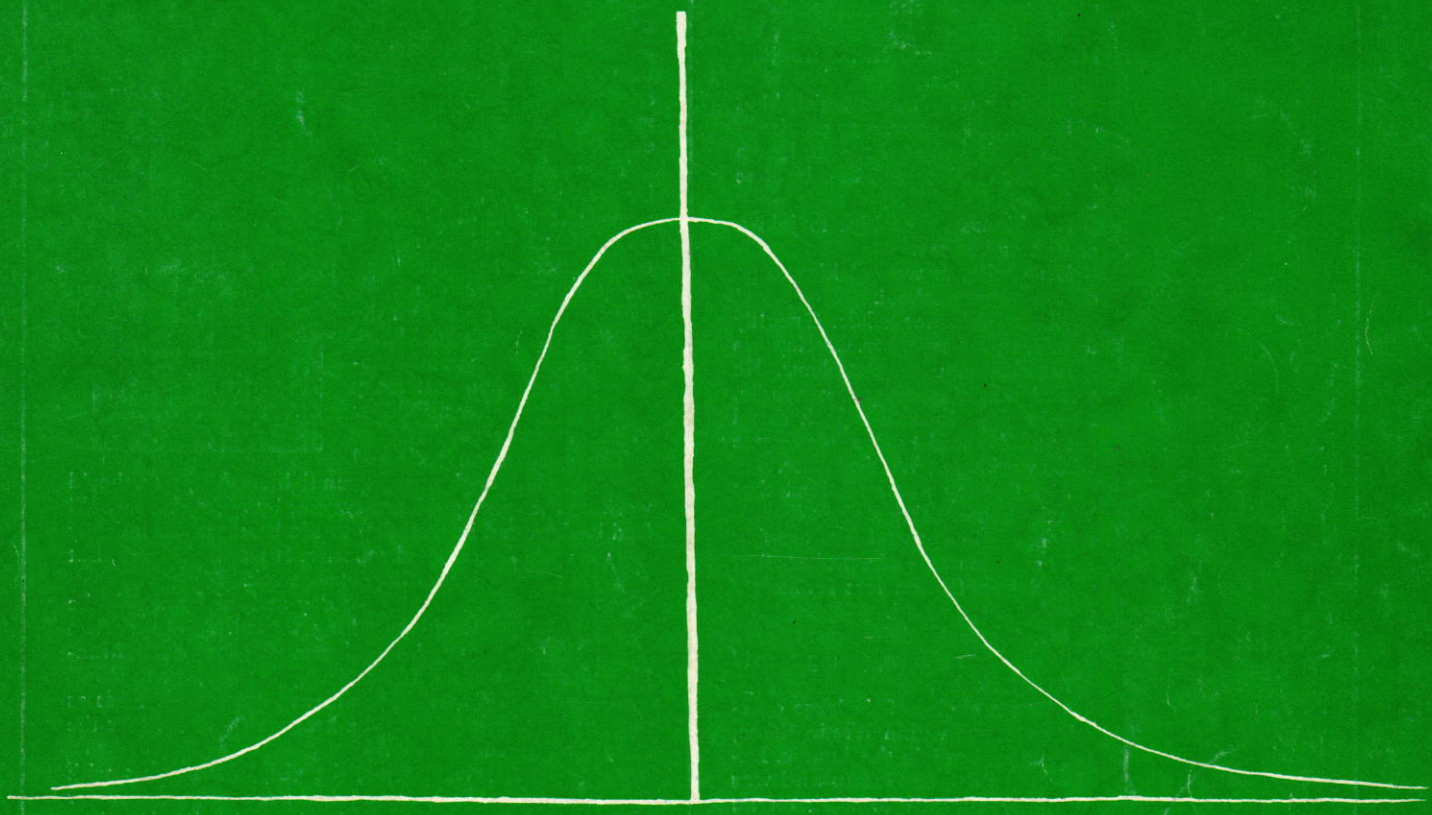
the Mechelectiv

Volume 25 November - 1966 No. 2



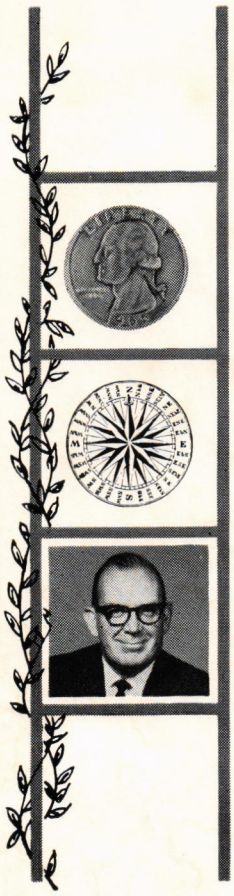
$$S^2 = \sum_{i=1}^{n} \frac{(X_i - \bar{X})^2}{n-1}$$

THE GEORGE WASHINGTON UNIVERSITY

NOVEMBER 1966

Go Westinghouse, Young Man!

A modern fable with technical overtones



Once there was a young college senior named Jack who wanted desperately to climb the beanstalk of success, facing the kind of challenges his forefathers faced on the frontiers of early America.

But Jack wasn't sure which kind of beanstalk he wanted to climb.

His mother wanted him to take a job at the local store so he'd be close to home.

His friends urged him to join a protest movement.

His professors wanted him to go on to graduate school.

Then Jack met a Mr. Greeley from Westinghouse. Mr. Greeley was a recruiter of college students. He was a kindly man with a warm smile, and he explained how Jack could get an advanced tuition-free degree while working at Westinghouse.

Mr. Greeley also explained that Westinghouse, being a giant organization, was in a much better position than most to undertake projects that would benefit the less fortunate peoples of the world.

Mr. Greeley's advice was:

"Go Westinghouse, young man!"

And Jack did.

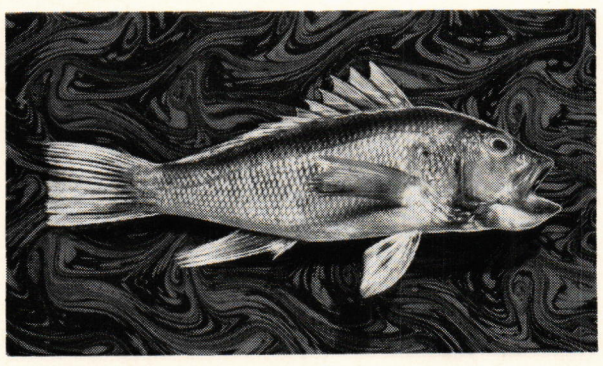
Given a choice of six large operating groups* within Westinghouse, Jack elected to join the Atomic, Defense and Space Group and was promptly assigned to work on an oceanographic project.

A fast learner, Jack took root quickly, reassuring his graying but still pleasant-faced mother, "Don't worry, Mom, I'm on my way to the top."

Though officially a trainee, Jack was a big help in the development of *Deepstar*—a Jules Verne-like underseas vehicle designed to explore the ocean depths. One of *Deepstar's* many missions was to search for food sources to meet the growing needs of a hungry world.

The project was an enormous success; Jack's management was delighted.

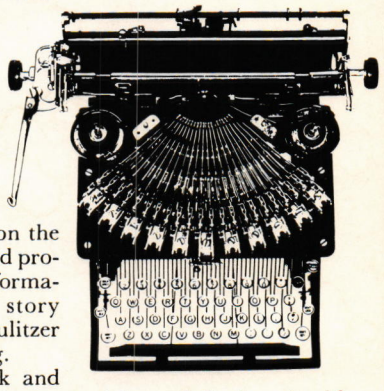
But before a grateful UNESCO could honor him publicly, Jack obtained a transfer to one of the many space projects Westinghouse coordinates.



Jack's assignment: help develop a rendezvous system for Gemini capsules.

To the news publications of the nation, this was the story of the year. In fact, one of the big syndicates assigned their most beautiful, technically oriented woman reporter to get an exclusive story from Jack . . . at any cost.

One night while returning from work . . . Jack was accosted by the beautiful young newswoman, who suggested that Jack give her an exclusive bylined story describing the project in detail.

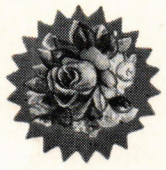


Though taken aback by her beauty, Jack never lost sight of his duty. He pleaded with the reporter to hold her story until after the launching. She agreed on the condition that Jack would provide her with enough information for a subsequent story that would win her a Pulitzer Prize for news reporting.

The pressure on Jack and his closely knit engineering team tightened. By day, they'd work on the space guidance system; by night, Jack would feed background information to the beautiful, technically oriented reporter. It was hard work, but it was important work.

Finally the day arrived for which the world had long waited. America's two capsules rendezvoused successfully. Mankind was now assured of a stairway to the stars.

While television-viewing millions rejoiced, Jack was as good as his word, offering the beautiful lady reporter the story she wanted so badly.



However, the girl, now smitten with Jack, turned her back on the Pulitzer Prize, preferring instead to join Westinghouse, attend its Advanced Education School and obtain a degree in engineering. (Women are welcome at Westinghouse, an equal opportunity employer.)

Now they both work at Westinghouse—while Jack designs atomic reactors for America's newest missile-firing submarines, his beautiful ex-reporter wife, an education specialist, helps train Peace Corps volunteers for overseas duty—and they're only a bean's throw from the neat white cottage they share with his mother.

And they all lived happily ever after.

Moral: By planting your career seeds with Westinghouse, you, too, can climb the beanstalk of success, overcoming giant obstacles and earning a lot of golden rewards.

You can be sure if it's Westinghouse

For further information, contact the Mr. Greeley from Westinghouse who will be visiting your campus during the next few weeks or write: L. H. Noggle, Westinghouse Educational Center, Pittsburgh, Pennsylvania 15221.

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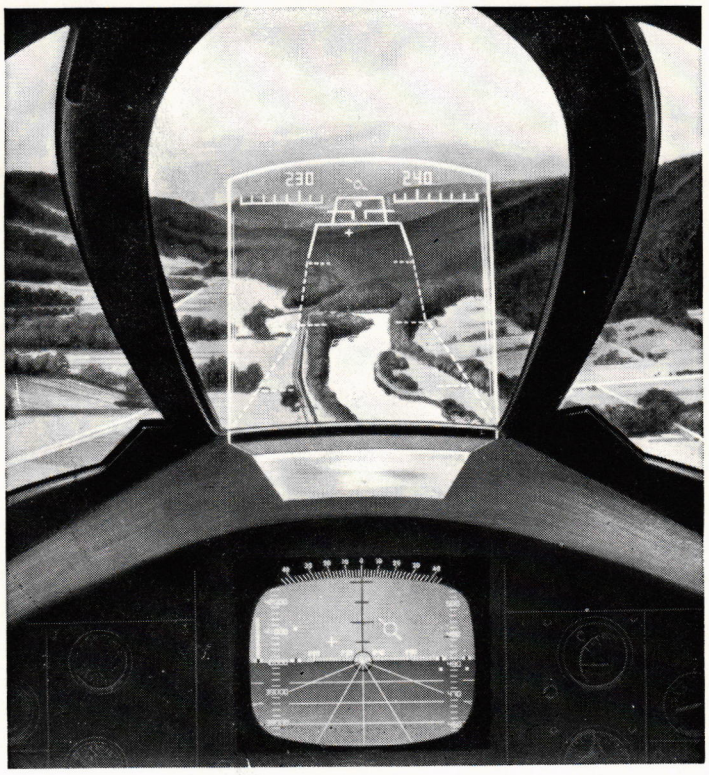

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CONSTRUCTION or DESTRUCTION

In engineering as in life, a good framework is a basic element for stability and durability. The engineering school has such a framework, however it looks as if the workers went on strike when it was not yet finished and all that is left is a large silhouette against an open sky.

The above statements do not refer to the physical appearance of the most modern building on campus, but to the student activities and the interest of the students which have waned since the activities began. The Engineering School has a very liberal atmosphere in which its activities may take place, but the majority of the students do not choose to use this freedom to their benefit. There is no other body of students in the University that has as much in common as the Engineers in terms of interest and courses of study, but in most cases the students have failed to use this fact to their advantage.

In recent years the framework of the school has not had proper maintenance and is about to deteriorate into oblivion. Most of the student leaders in the school who have been the pillars of strength in the recent past are either leaving or have given up hope of ever reviving the motivated student body which was once had by the school.

The purpose of school is for the growth of the student. This growth should be both through the process learning and the process of professional maturing. The School of Engineering and Applied Science gives the student the opportunities and the freedom to grow as he sees fit. It is truly a shame that most students are passive rather than active in school functions and thereby limit their growth to the academic aspect. Most of the functions in the school serve a twofold purpose; the improvement of the student, and the improvement of the school. These functions are as members in the framework of the school and increase its stability. If these members become non-existent, the school will crumble.

The participation of the student body is certainly an important part of the school. When a building crumbles, no single rivet or member feels responsible, however they all are. It is up to the students to keep the Engineering School from falling to pieces. In its present state of interest the student body is acting more as a wrecking company than a responsible construction firm. With the power that is within the students it will not take long to level the structure.

--A.S.D.

the Mechelecivv

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page

ARTICLES

THE APPLICATION OF THE METHOD OF LEAST SQUARES
by J. Dougherty 8

DEPARTMENTS

Editorial 3

Letters to the Editor 6

Faculty Spotlight 10

Campus News 14

Theta Tau 15

Tech News 16

Mech Miss 20

Job Interviews 23

The Shaft 24

COVER

Since our main article this month deals with Least Squares our cover shows the familiar Bell Shaped Curve, and the Standard Deviation formula.

FRONTISPIECE

The Engineering Alumni Board at a board meeting.

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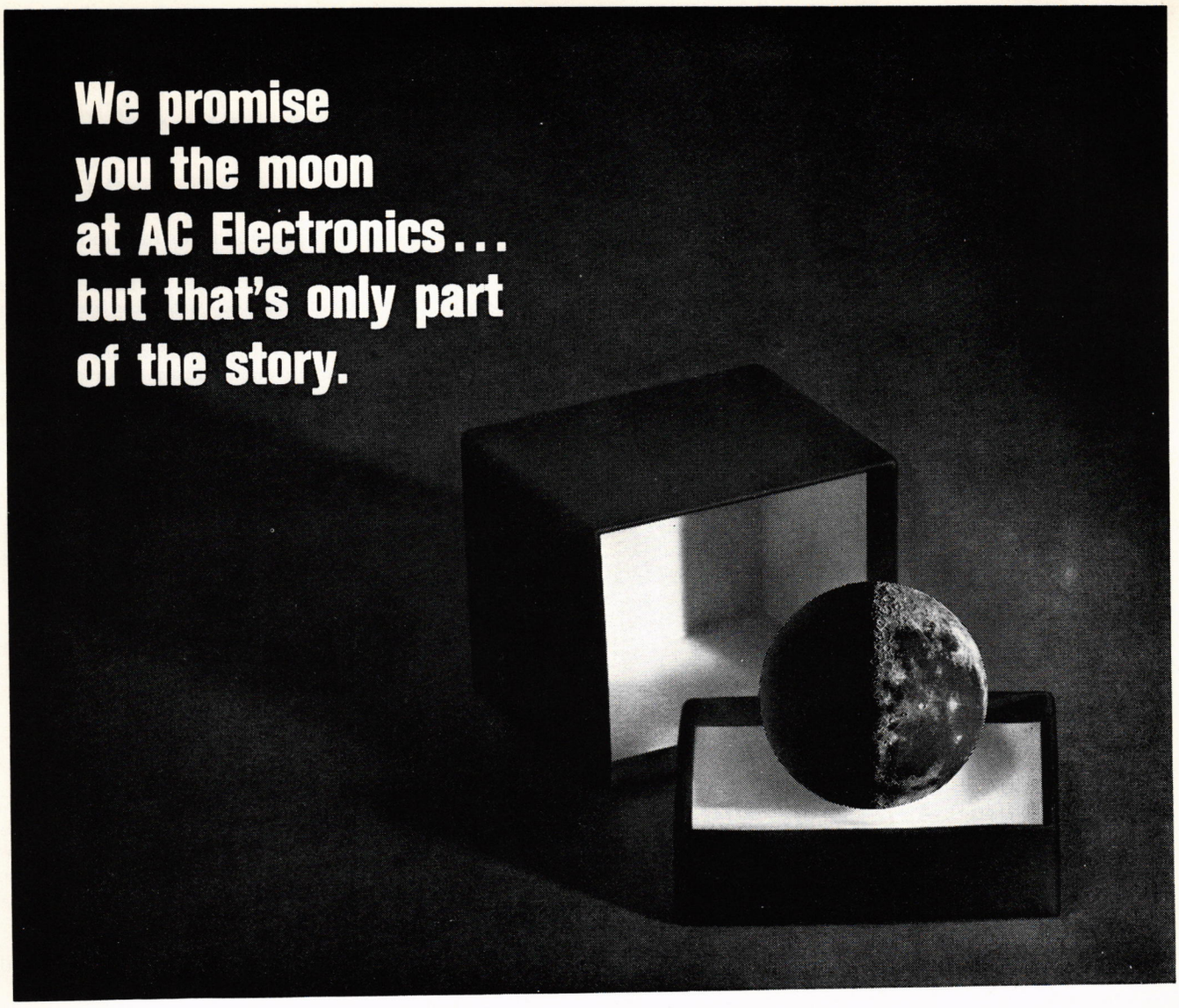

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LETTERS TO THE EDITOR

An Open Letter to the Dean, Faculty, and Students of The George Washington University School of Engineering and Applied Science

Since I first came to school at G.W.U., I have found a number of questions constantly reappearing in my mind which, I feel, require answers. This year, as chairman of the student chapter of the Institute of Electrical and Electronic Engineers, I feel that these questions have become so insistent that you must see them and provide the answers for me and for yourselves.

1. Is there an attempt to show how an engineering education relates to what engineers are doing outside this ivory tower ... or to what they might do?

2. Is there an attempt to develop professionalism in the student body of the engineering school?

3. Is there an attempt to develop individual leadership, confidence, and responsibility in the engineering student?

4. Is there an attempt to develop the individual creative ability and understanding in the engineering student beyond that normally expected in the field of engineering?

5. Is there an attempt to develop the engineering student beyond a rigorous technical education?

6. In short, is there an attempt to develop in the engineering student those things which he will require to succeed beyond the success of being a mere tool after graduation?

The answer to all of these questions but one is a resounding NO! The answer to the first one is a meek yes, and there is brief "lip service" paid to the second.

1. The "meek yes" which answers the first question is that of our three professional societies, which retain only toleration from the administration and faculty of the engineering school. Exceptions to this toleration occur spasmodically and briefly, but any support which exists has not, in my memory, been official. This, in itself, is a very good reason for the reluctance of the student body to attend and support those societies which operate in their respective fields of interest. Further, it is an even better reason for the reluctance of the student body, as individuals, to accept any responsible positions concerned with these societies.

2. The brief "lip service" paid to professionalism comes at the beginning of each year with the dean's address to entering freshmen, in which he mentions professionalism. This is, most likely, the last time these new freshmen will hear the word until after they graduate and become practicing engineers. Although these freshmen were told that engineers are different, that the engineering outlook is taken from a different point of view, they will find very little difference in the outlook and enthusiasm for any given course of instruction in engineering than that which is found anywhere else in The George Washington University.

Why, then, are they told that this difference exists between engineers and non-professionals? Because the difference does, in fact exist everywhere--except at George Washington.

It would be very desirable if these "professionals" became acquainted with the idea, meaning, and attitude of professionalism. Each of the professors and instructors could and/or would set the example if the enthusiasm existed to do it or if there were a definite program (specified desire) of the administration for the engineering students to learn this idea, meaning, and attitude.

3. Looking at the third question, we find that only certain individuals ever have the chance to develop leadership, responsibility, or confidence. These are individuals who, for the most part, already had these qualities before entering G.W.U. We are told that the nation's colleges supply the nation's leaders--this may well be true, but the question arises as to the validity of this statement when observing the example presented the student body in the person of the faculty, which contains few but shining examples of leadership.

The development of leadership and responsibility and confidence occurs only with an example and within an atmosphere which cultivates these qualities; that is, an atmosphere in which they are both desirable and expected. This problem pervades the entire atmosphere of G.W.U., not just the engineering school. We do not pretend to monopolize apathy, but it would be nicer if we had none at all.

We are told that our engineering school is unique because the students operate many of the things which are taken care of by the faculties in other schools. This indicated two things: (a) Student enthusiasm, and (b) Apathy from other quarters.

Why must the student organizations -- The Engineers Council, Sigma Tau, Tau Beta Pi, Theta Tau, ASCE, ASME, IEEE--carry the ball without enthusiastic official support from the administration and faculty? Because there doesn't seem to be any support from these places.

4. If the colleges and universities of the nation are expected to develop the leadership of the nation, then the fourth question must not only be satisfactorily answered, but its answer must be applied. It is an obvious question in the face of the fact that engineers are assuming greater roles of responsibility which require such things as creative ability and understanding. Remembering that we who aspire to the engineering profession must, of necessity, be educated longer and more intensively than others, excepting those in law and medicine, why cannot there be a more complete education within our own professional school, such that creative ability and understanding play an important role, as they should?

5. As for the fifth question, I say--Why not! The responsibility that an engineer faces after graduation requires more than technique, more

--Continued on Page 9

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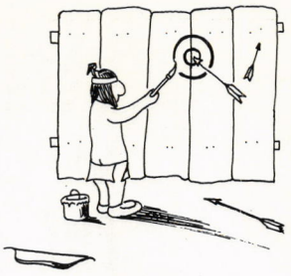
APPLICATION OF THE METHODS OF LEAST SQUARES TO CALIBRATION DATA . . .



by Jack D. Dougherty

Many devices are calibrated by imposing upon a measuring device a known quantity and observing the response. For an example, a thermocouple device for monitoring radio frequency power is calibrated by observing the millivolts registered by the thermocouple when known amounts of power are established. Usually only a few power levels will be used for calibration and it is important to establish a mathematical relation between the RF power level in watts and the thermocouple reading in millivolts.

To explain this concept, a sample calibration of such a thermocouple is used. The device is calibrated at four levels of RF power. A graph of the resulting data is shown.

Thermocouple Output in Millivolts

RF Power in Watts

EMPIRICAL FIT

In the absence of any theoretical function relating the two quantities, it is often quite satisfactory to use an empirical function. One commonly used function is of the form $Y = a + bx + cx^2 + \ldots$. For the example cited, Y corresponds to the thermocouple output, and x to the RF power. It is often sufficient to stop with the second power of x for smooth curves.

Using the calibration data, the coefficients "a", "b", and "c" must be determined for each individual device. These coefficients can be found by fitting the data to the curve by the method of least squares, i.e., by finding the curve which gives a minimum sum of the squares of the deviation of each observed point from the curve. Expressed algebraically, this is the curve for which $\Sigma (y-Y)^2$ is a minimum, where y is the observed value of thermocouple output and Y the value read from the curve for each level of RF power.

Expressions for a, b, and c are derived as follows:

$$\Sigma (y-Y)^2 = \text{minimum}$$

$$\text{since } Y = a + bx + cx^2$$

$$\Sigma (y-a-bx-cx^2)^2 = \text{minimum}$$

$$\Sigma (y^2+a^2+b^2x^2+c^2x^4-2ay-2bxy-2cx^2y+2abx+2acx^2+2bcx^3) = \text{minimum}$$

METHOD FOR MINIMUM ERROR

This expression is minimized by differentiating it and setting the derivative equal to zero. Since three coefficients are to be determined, it is differentiated three times, once with respect to each coefficient.

$$\frac{\partial}{\partial a} \quad 2a-2y+2bx+2cx^2 = 0$$

$$\frac{\partial}{\partial b} \quad 2bx^2-2xy+2ax+2cx^3 = 0$$

$$\frac{\partial}{\partial c} \quad 2cx^4-2x^2y+2ax^2+2bx^3 = 0$$

Each term must include all observed points. To do this, the above equations are re-written:

$$na - \Sigma y + b\Sigma x + c\Sigma x^2 = 0$$

$$b\Sigma x^2 - \Sigma xy + a\Sigma x + c\Sigma x^3 = 0$$

$$c\Sigma x^4 = \Sigma x^2y + a\Sigma x^2 + b\Sigma x^3 = 0$$

where n is the number of observed points.

When these three equations are solved, the results are:

$$b = \frac{\frac{n\Sigma x^2y - \Sigma x^2 \Sigma y}{n\Sigma x^4 - (\Sigma x^2)^2} - \frac{n\Sigma xy - \Sigma x \Sigma y}{n\Sigma x^3 - \Sigma x \Sigma x^2}}{\frac{(\Sigma x)^2 - n\Sigma x^2}{n\Sigma x^3 - \Sigma x \Sigma x^2} - \frac{\Sigma x \Sigma x^2 - n\Sigma x^3}{n\Sigma x^4 - (\Sigma x^2)^2}}$$

$$c = \frac{n\Sigma xy - \Sigma y \Sigma x}{n\Sigma x^3 - \Sigma x \Sigma x^2} \frac{[b+(\Sigma x)^2 - n\Sigma x^2]}{}$$

$$a = \frac{\Sigma y - b\Sigma x - c\Sigma x^2}{n}$$

If each device is calibrated at the same levels of RF power, the denominators of these fractions have to be computed only once.

A thermocouple responds to power, therefore at zero RF power the output of the thermocouple should be zero and the value of the coefficient "a" should be zero. However, for the example cited, no measurement is made at zero RF power and the coefficient "a" should be retained and calculated.

Since different instrumentation would be required to measure the thermocouple output at zero RF power, a separate investigation is required for each type of thermocouple and ambient conditions of concern. From the results of such an investigation, it would have to be decided if "a" can be assumed zero or if a value has to be calculated.

The results of a least squares fit to one set of calibration data are:

Power	Thermocouple Output Observed	Calculated	Deviation	Deviation Squared
x	y	Y	y-Y	$(y-Y)^2$
3	7.799	7.808 60	− .009 60	$.92 \times 10^{-4}$
6	14.598	14.573 45	+ .024 55	3.57×10^{-4}
10	22.099	22.126 36	− .027 36	7.48×10^{-4}
12.5	26.008	25.995 60	+ .012 40	1.54×10^{-4}
				$\Sigma = 13.51 \times 10^{-4}$

a = + 0.100 74
b = + 2.726 453
c = − 0.052 389 214

The thought may have occurred that the range of operation on the thermocouple response curve is small enough that a linear fit to the data is sufficient. This hypothesis can be tested as follows. The observed data is made to fit the linear relationship

$$Y = a + bx$$

A derivation similar to that presented previously results in

$$b = \frac{n \Sigma xy - (\Sigma x)(\Sigma Y)}{n \Sigma x^2 - (\Sigma x)^2}$$

$$a = \frac{\Sigma y}{n} - \frac{b \Sigma x}{n}$$

where n is the number of observed values.

When the data used above is substituted into these expressions and the sum of the squares of the deviation of each point from the linear curve is obtained, the result is $36{,}244 \times 10^{-4}$. Since four data points were used to obtain two coefficients, two degrees of freedom for estimating error remain. This residual sum of squares is divided by two to give the residual sum of squares per remaining degree of freedom. This gives $18{,}122 \times 10^{-4}$ which may now be compared with residual sum of squares obtained when the coefficient "c" was considered. Using three terms the residual sum of squares was 13.5×10^{-4}. Because four observed points were used to establish three coefficients, this sum of squares is for one degree of freedom only.

RATIO TEST FOR REDUCING ERROR

A ratio test can now be made to determine how effectively the coefficient "c" reduced the residual sum of squares in relation to the sum of squares remaining after it was added. For those unfamiliar with statistical procedures, tables (F tables) are available to appraise the reduction when expressed in terms of the average reduction that could be obtained per remaining degree of freedom. The F ratio can, by chance, vary around a value near unity if "c" is not improving the fit. The tables give limits to the size of F considering the confidence level desired and the number of degrees of freedom. Using the above data:

$$F = \frac{18{,}122 \times 10^{-4} - 13.5 \times 10^{-4}}{13.5 \times 10^{-4}}$$

$$F = \frac{18{,}108.5}{13.5} = 1341$$

The large value of F is evidence of a substantial improvement in fit by using $Y = a + bx + cx^2$ instead of $Y = a + bx$.

The interpolation and extrapolation of data using the curve established above can be accomplished without difficulty. Extrapolation should be used only after a detailed analysis of the specific case.

As thermocouples of a particular type are calibrated, a collection of the deviations of observed values from calculated values at each power level and the sum of the squares of the deviations can be accumulated. Each succeeding calibration can then be compared against this history. If the calibration of a particular unit results in an unusually large sum of squares, the calibration can be repeated.

If the deviations at each power level have a distinct consistent pattern, this pattern can be used to guide the analysis of and reduction of the error of such calibration point. Such a pattern may also indicate the need to change the general mathematical relationship being fitted.

A check on the curve obtained and on the general relationship which was used can be made by observing several intermediate values and comparing these with calculated interpolated values. This should be done whenever any such program is initiated.

SUMMARY

In conclusion, the response of a device can often be expressed as a mathematical relationship. Calibration data can be used to establish the specific relationship for a particular device. The three benefits resulting from this procedure can be summarized as:

(1) An estimate of the random error of the series of measurements is available.

(2) A means now exists for interpolating to obtain values intermediate between the measured points.

(3) The data can be extrapolated to obtain values beyond the measured points; this should be done with caution.

LETTERS TO THE EDITOR (Continued)

than formulae, more than a specific technical instruction, more than the beginning liberal arts courses, the last of these being little more than a palliative which is called broadening.

6. To the last question, I answer--there should be. A tool and a human being are two different things, but a human being can be made into a tool for others. Why should this be? Why can we not use our own talent to its own best ends? The answer is simple; the implementation is not. For fifty-four dollars a credit hour, or eight hundred dollars a semester, can you show no concern? For the rest of your life, can you afford an inadequate education now?

John W. Lindsey, Chairman, student chapter
Institute of Electrical and Electronic Engineers
Davis-Hodgkins House, 731 22nd St., N.W.
Washington, D. C. 20006

Any replies are welcome at the above address.

FACULTY SPOTLIGHT

by Perry Saidman

Dr. A. V. M. Ferris-Prabhu

One of the welcome new faces on our full time faculty staff belongs to a widely traveled man who sports Bachelor's and Master's degrees in mechanical engineering and a Doctorate in solid state physics. The multi-talented professor is Dr. A. V. M. Ferris-Prabhu who was born in Bangalore, India where he attended St. Joseph's School prior to his journey to the United States in 1954.

As an undergraduate he attended the University of Dayton in Ohio where he distinguished himself by winning a regional ASME essay contest and a trip to San Francisco where he presented his paper on Engineering Education. After receiving his BSME in 1957, he gained professional experience at IBM Research Laboratories Poughkeepsie, N. Y. as a mathematician in their computing center. He received his Masters degree from Princeton University in March 1960 whereupon he joined Catholic University's research staff working at that time on Fermi surface calculations. Dr. Ferris-Prabhu's technical interest turned to the study of physics "in order to get a better understanding of the 'why' of natural phenomena rather than putting its results to work." He delivered his Doctoral dissertation in April 1963 on "The Spin Wave Theory of Ferromagnetism". He was then awarded a post-graduate Fellowship at the Massachusetts Institute of Technology where he became involved in the calculation of the critical temperatures and susceptibility of ferromagnets.

From June 1964 until joining our faculty this fall, Dr. Ferris-Prabhu was working with the Radiation Physics Group at Goddard Space Flight Center in Greenbelt, Md. on the statistical analysis of lattice defects in semiconductors. He is very proud of his recent paper on "Spectral Analysis of Radiation Damage in Silicon" which was delivered at the International Symposium on Lattice Defects in Semiconductors in Tokyo, Japan just last September.

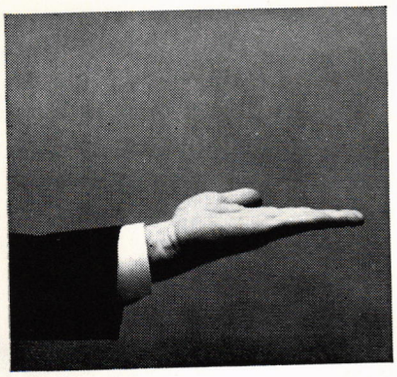
At G. W., in addition to teaching courses in advanced engineering math and materials science, Dr. Ferris-Prabhu has joined the research group directed by Dr. Galip Arkilic, Chairman of The School's Engineering Mechanics Department. They are actively engaged in the application of solid state principles to continuum mechanics, which is basically the study of materials from a microscopic viewpoint. Dr. Ferris-Prabhu also manages to participate in seminars at Georgetown and Catholic Universities dealing with superconductivity and statistical mechanics.

Outside of his professional world, Dr. Ferris-Prabhu remains an eligible bachelor at the age of 34, an avid tennis player, and a staunch admirer of the theater and the ballet. His attitudes towards teaching and learning indicate he feels students should work a lot harder than they actually pretend to do, citing as a good starting point better pre-class preparation. "If a student has read the lecture material carefully and is ready to put meaningful questions to the professor, the lecture session is likely to be much more productive, both for the class and professor." He is opposed to rote memorization but is convinced that meaningful repetition results in a more valuable mental retainment.

Dr. Ferris-Prabhu is also the author of many papers and holds memberships in Tau Beta Pi, Sigma Xi, and the American Physical Society. We are happy to welcome him to SEAS and look forward to a mutually rewarding association.

The Rain in Maine is Plainly

$$D = \frac{SNR}{SNR_o} = \frac{t/T_{SYS}}{t_o/T_{SYS_o}} = t_x \frac{T_{SYS_o}}{T_{SYS}} = \frac{\Delta - 1}{\Delta_o - 1}^*$$



Attention to detail is an old Bell System habit. Or maybe you call it thoroughness. Or follow-through.

Anyway, we attended to an interesting detail recently—the effect of rain on the microwave link between a communications satellite and our pioneer ground station antenna at Andover, Maine.

If we could but measure the rain's effect, we could improve the design of satellite ground stations. The question was how.

Well, you often have to take your laboratory tools where you find them, and in this case we found ours in Cassiopeia A, a strong and stable radio star that is always visible from Andover. We measured the noise power from Cassiopeia A during dry periods, and then measured the reduction during rainy periods. The result could be expressed as a formula and employed accurately in designing future ground stations.

The initial success of our Telstar® satellites proved the feasibility of communicating via space.

But it also opened the door—or the heavens—to a whole new technology which we are now busily exploring in every detail.

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Sometimes we know when not to come in out of the rain.

* * *

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AT&T Bell System
American Telephone & Telegraph and Associated Companies

*The definitions and derivation, plus further information on satellite transmission degradation due to rainfall, may be found in the Bell System Technical Journal, Vol. XLIV, No. 7, Sept., 1965, p. 1528, which is available in most scientific and engineering libraries.

NEWS for 1966 1967 ENGINEERING GRADUATES

Continued expansion of our military and commercial business provides openings for virtually every technical talent.

As you contemplate one of the most important decisions of your life, we suggest you consider career opportunities at Pratt & Whitney Aircraft. Like most everyone else, we offer all of the usual "fringe" benefits, including our Corporation-financed Graduate Education Program. But, far more important to you and your future, is the wide-open opportunity for professional growth with a company that enjoys an enviable record of stability in the dynamic atmosphere of aerospace technology.

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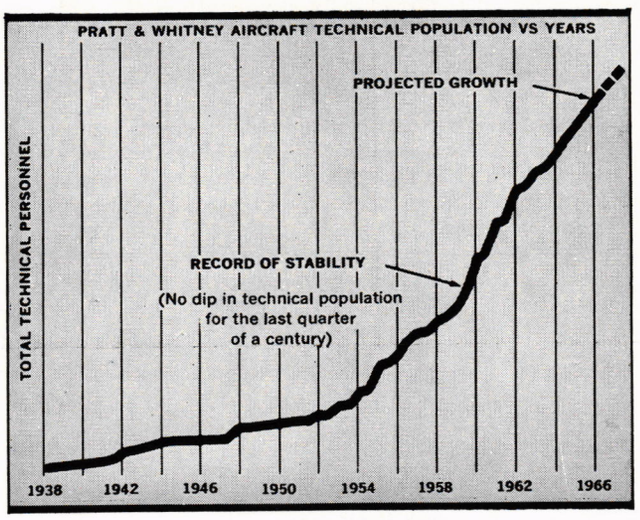
For further information concerning a career with Pratt & Whitney Aircraft, consult your college placement officer—or write Mr. William L. Stoner, Engineering Department, Pratt & Whitney Aircraft, East Hartford, Connecticut 06108.



Take a look at the above chart; then a good long look at Pratt & Whitney Aircraft—where technical careers offer exciting growth, continuing challenge, and lasting stability—where engineers and scientists are recognized as the major reason for the Company's continued success.

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CAMPUS NEWS

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS

G.W.U. Student Chapter

The last two meetings of the I.E.E.E. have been very interesting as demonstrated by the fact that the speakers were both held well beyond the normal lecture period by questions from the audience. The second lecture on power distribution was very well presented in an easy, relaxed manner. It was extremely interesting and a natural followup to the first meeting of combined sponsorship on Atomic Power.

Mr. Joseph Branch of the Potomac Electric Power Company was our speaker. His presentation was excellent and with a few unexpected points of interest thrown in. The attendance was terrible --only ten people came. Those who did not come missed quite a few things that they will never get in any classroom on the George Washington campus, in fact, you probably won't see most of what was discussed outside the classroom at G.W.U.

On the surface the topic didn't seem very interesting, but Mr. Branch applied his long experience in the field to bring up points which were both unexpected and worthwhile. Those were there seemed pleased with both the presentation and the refreshments afterwards, and I hope to see you all when the next meeting rolls around.

Many of you who are members didn't take the time to drop in and missed a valuable lecture. Those of you who are in the electrical and electronic fields are welcome at any and all of our functions. We are doing our best to present topics of interest in two series this year: the first, on power generation and distribution; the second, on communications and data. If there is no support from you we can't expect to get as good a presentation as we would like.

Help us make our program more interesting to you -- give us suggestions -- support our efforts and I am sure that you won't be disappointed. Our posters advertising appear about three to seven days prior to each meeting with the subject matter to be covered outlined clearly.

Any suggestions you have are welcome.

--John W. Lindsey

T (n) T — THETA TAU

by Doug Lowe

This is the last year of undergraduate study for many of us in SEAS, whether it be our fourth, fifth, ninth, or twentieth year here. The paths down which we each head after the college doors close behind us will be difficult at times, but hopefully will lead through successful, satisfying lives. Academic preparation has taken a large part of the past few years. Personal and professional development has progressed concurrently.

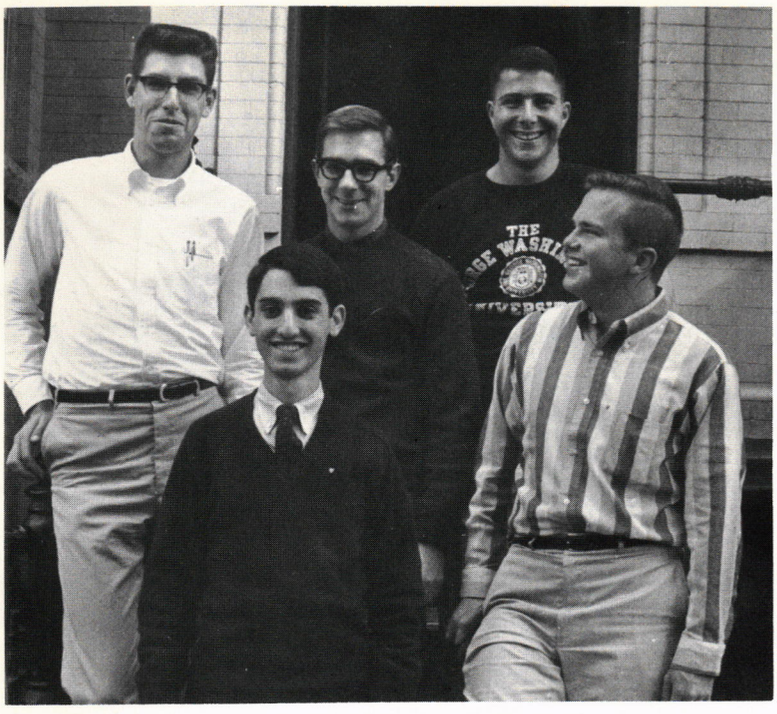
We would like to pass on some information that could be of interest to you regarding one of the School's organizations that helped us quite a bit: Theta Tau. Quoting from a letter written by Martin Felker, Theta Tau is

> "George Washington's only professional engineering fraternity. A fraternity is a serious and/or social gathering of fellows who have enough in common to want to act together in brotherhood. It sounds academic, but that's just what Theta Tau is: men who have gotten together at picnics, at meetings, at banquets, and at dances, and on the athletic fields to enjoy each other's company and to have a good time. In time of need (exams, term papers, lab reports) any bother may be called upon to render his utmost and humble service. We are basically a social fraternity, but great emphasis is placed on professionalism, either directly by presenting outside professional speakers or indirectly by exposure to our own brothers who are already professional engineers. Consequently, even though our Q.P.I. requirement is only 2.0 or better, we do applaud engineering students who take their studies seriously. Engineers by nature are economy-minded and we try to balance our program in such a way that our costs are held to a minimum. Membership is not limited to only full-time single students. In fact, many of our functions cater to part-time and to married students."

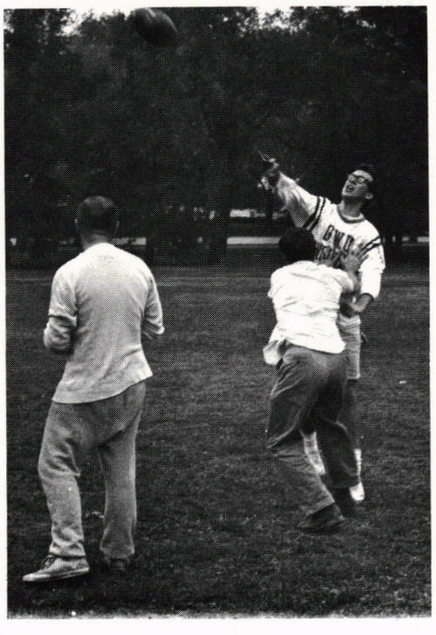
Those are the basic facts about the fraternity. We feel that the friendships made, the activities participated in, and the responsibilities accepted and handled during our years of membership in Theta Tau will benefit us always. We would strongly encourage you to seek these benefits for yourself.

If you are hesitant about committing yourself to any organization, that is unfortunate, especially for you. We hope that you will overcome your hesitancy.

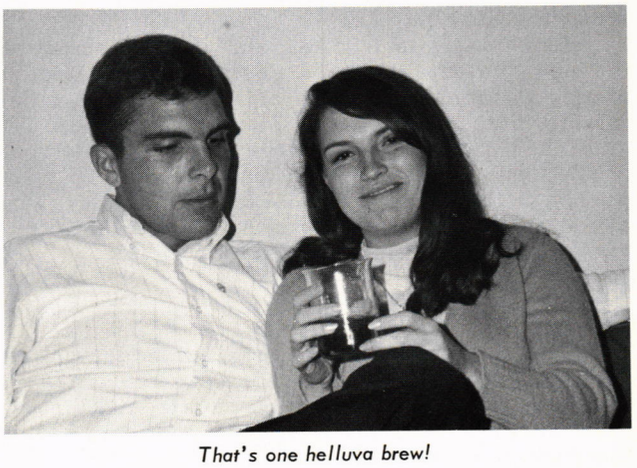
Θ T



Kastner, Marenberg, Butteriff, Staats, Taylor

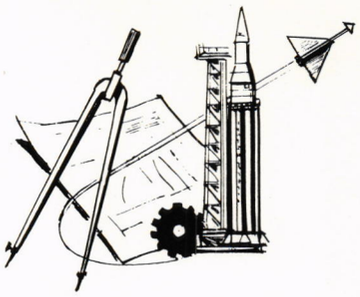


Ooooo—Sandy I never thought you'd ask



That's one helluva brew!

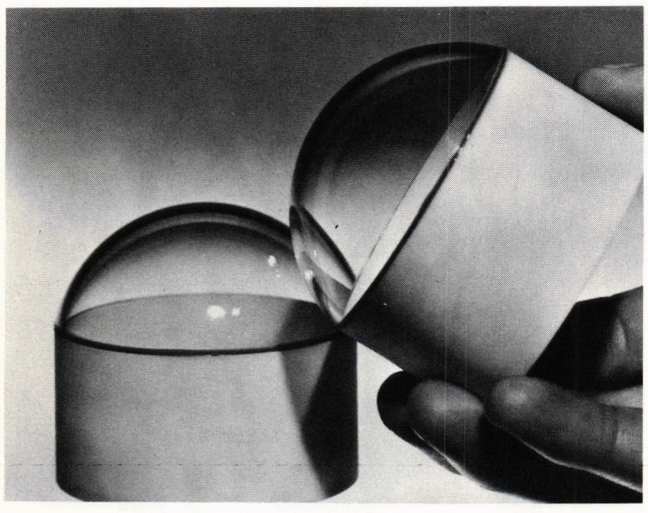
TECH NEWS



by Tim Stegmaire

NEW GLASS HELPS GI'S

A new glass composition with extended infrared transmission serves as part of the "eye" of Redeye--the shoulder-fired surface-to-air missile.



The new material, trademarked Cortran, is used for the 2-1/2-inch-diameter nose dome on the heat-seeking Redeye. The glass, Corning Code 9753, transmits 82 percent of infrared energy at 4 microns (40,000 Angstroms).

Transmittance at shorter wavelengths is essentially the same down to about 400 millimicrons (4,000 Angstroms). Sharp cutoffs occur at each end of the transmission band.

Code 9753 glass is a calcium aluminosilicate composition developed by Corning Glass Works. The glass has excellent resistance to corrosion and rain erosion, and also has high mechanical strength, Corning said.

Because it is a glass and easily formable, the new material is less costly for the Redeye program than exotic materials used for other missile systems.

The 4.3-foot-long Redeye missile, developed by General Dynamics/Pomona, weighs only 20 pounds. The Redeye arms the foot soldier with a potent anti-aircraft weapon. The missile can track, chase and hit a strafing jet fighter.

GLASS IN THE SEA

Recent tests by an oceanographic design and engineering company indicate that scratches on the outside of spherical glass floats and instrument packages may not degrade performance of the spheres under the sea.

Designers of deep submergence equipment often have questioned whether scratches and normal handling in service might cause glass spheres to break under pressure.

Benthos, Inc., North Falmouth, Mass., recently conducted severe scratch and pressure tests on two 8-inch-diameter hollow glass spheres supplied by Corning Glass Works. Benthos, a leader in its field, uses glass spheres as floats and instrument packages for deep submergence systems.

Each of two spheres tested were first deeply scratched with a carbide scriber in about 100 places. Some of the scratches actually were gouges more than a tenth of the wall thickness in depth.

The spheres were then tested by holding them in a hydrostatic chamber for 16 hours at their design pressure rating of 15,000 psi (equivalent to more than 30,000-foot ocean depth).

The spheres were still serviceable after the test. According to Benthos, the pressure testing improved the condition of the scratched spheres. The sharp edges of the scratches spalled off, leaving the spheres smoother than before.

Glass normally fractures under tension, not compression; this is why glass is extremely strong under compressive loading. Fractures are usually initiated by surface flaws such as scratches. Benthos and Corning Engineers theorized that in testing under hydrostatic loads the compressive forces greatly reduced the stress concentrations normally associated with scratches.

One of the spheres tested was set aside and a notch was filed in the other 1/16-inch wide, 0.03-inch deep and one inch long. This sphere again survived testing to 15,000 psi.

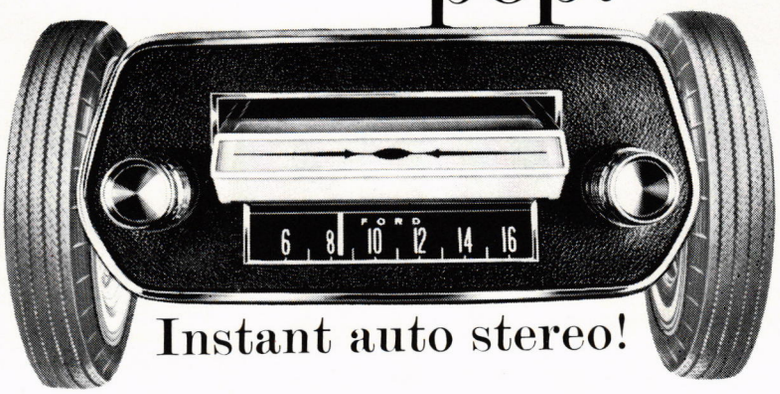
The same sphere then was ground with a high speed grinding wheel leaving a notch 1/4-inch wide, 0.08-inch deep -- one-third the wall thickness -- and an inch long. With this severe damage, the sphere went to 9,500 psi before failure.

Benthod and Corning are cooperating to gather more extensive data about the effects of scratches on sphere strengths, including scratches on inner as well as outer surfaces.

Glass is useful in the sea because of its buoyancy (high strength-to-weight ratio), which allows relatively thin-walled components to meet the requirements of deep submergence.

CONSUMER PRODUCTS ★ COMMUNICATIONS ★ SEMICONDUCTOR PRODUCTS ★ GOVERNMENT ELECTRONICS ★ AUTOMOTIVE PRODUCTS ★ CONTROL SYSTEMS

snap!
concert!
pop!



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More so than ever before, the automobile is becoming equipped like your home. Motorola engineers have designed and built AM radio, FM radio, push-button radio, and Vibrasonic radio. Now, a high-quality, hi-fi stereo tape player for the brilliance of three-dimensional sound, already offered by Ford Motor Company as optional factory or dealer installed equipment.

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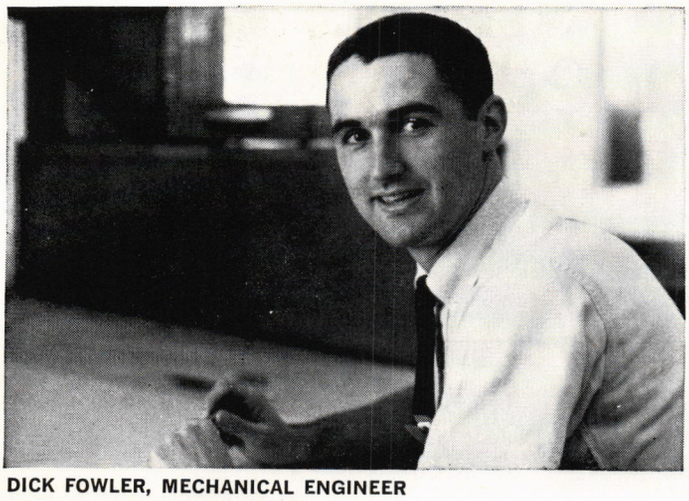
From highway to home—lab to launch site—Motorola electronics engineering brings exciting futures to your fingertips.

TRUST THIS EMBLEM WHEREVER YOU FIND IT

MOTOROLA

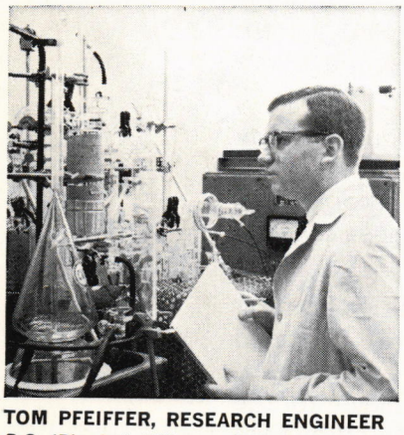


DICK FOWLER, MECHANICAL ENGINEER
M.E., University of California (Berkeley) '64

BILL RHONE, SYSTEMS ENGINEER
Ch.E., Bucknell University '63

They're on the move at Bethlehem Steel

BETHLEHEM STEEL



TOM PFEIFFER, RESEARCH ENGINEER
B.S. (Physics), Villanova College '62

BOB SIMS, ELECTRICAL ENGINEER
E.E., Tennessee A & I '65

STEW EASTERBY, SALES ENGINEER
B.S.C.E., University of Mississippi; M.S., University of Missouri '64

Have you heard about all the opportunities for engineers and other technical graduates at Bethlehem Steel? You'll find a great deal more information in our booklet, "Careers with Bethlehem Steel and the Loop Course." You can obtain a copy at your Placement Office, or drop a postcard to Manager of Personnel, Bethlehem Steel Corporation, Bethlehem, Pa. 18016.

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JAKE REED, METALLURGICAL ENGINEER
Met.E., Pennsylvania State University '63

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It isn't always easy, but most times it works out fine. For Allied Chemical is a large company whose various operating divisions embrace over 100 plants...12 research and development centers ...and a coast-to-coast network of sales offices. Our product list exceeds 3,000. Our interviewer will try to help you find a job within this vast complex that suits your talents, inclinations, and college training. One you'll want to stick with and grow in.

Ask your placement office when our interviewer will be on campus. Come prepared with all the questions you can think of and ask for information. You'll get it—and more. If you can't meet with him, write to: Director of Placement, Allied Chemical Corp., 40 Rector Street, New York, N.Y. 10006.
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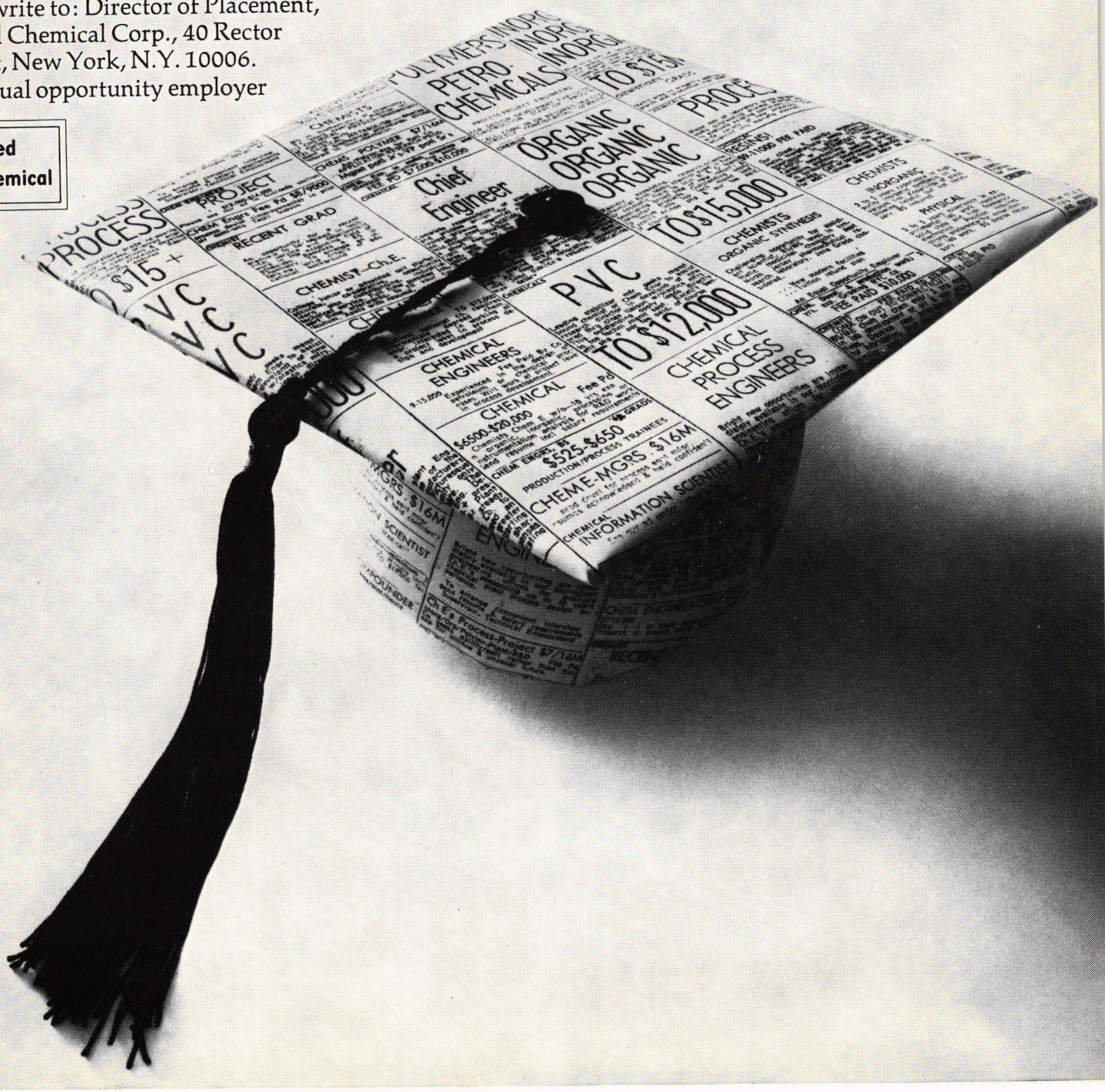


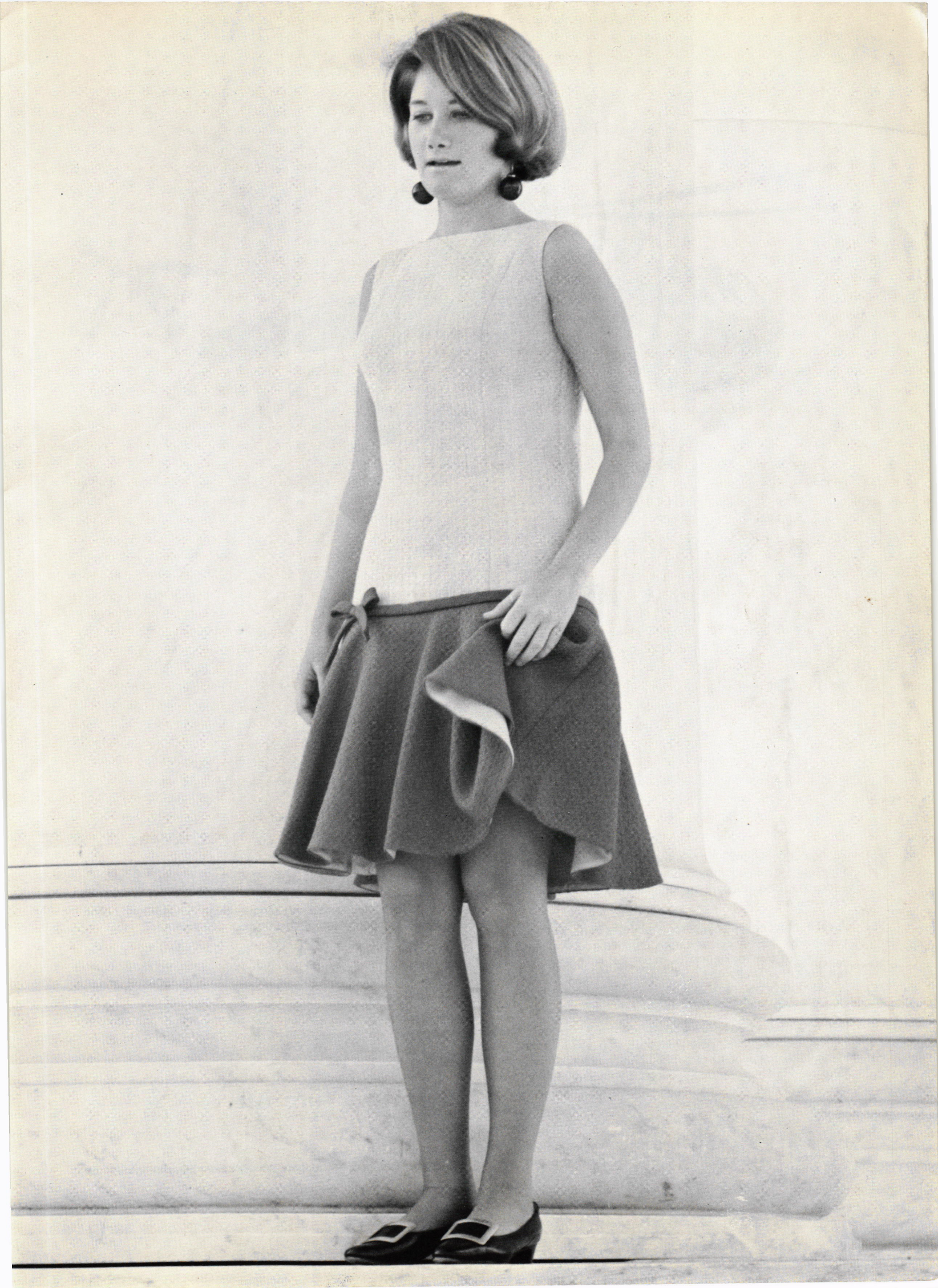
MECH MISS . . .

November's Mech Miss, blond-haired, blue eyed Sandra Altman is an 18 year old freshman from Charleston, South Carolina. Sandra is no newcomer to modeling, having gained experience in her hometown stores. Here at G.W. Sandra wants to major in sociology with hopes of becoming either a psychiatric social worker or a juvenile court caseworker.

She combines a love of beachcombing, reading poetry (preferably Edna St. Vincent Millay and Robert Frost), and playing basketball with a large quantity of bubbly spirits to come up with a winning personality.

SANDRA ALTMAN

Clothing Courtesy of Trapeze, Inc. (Georgetown)



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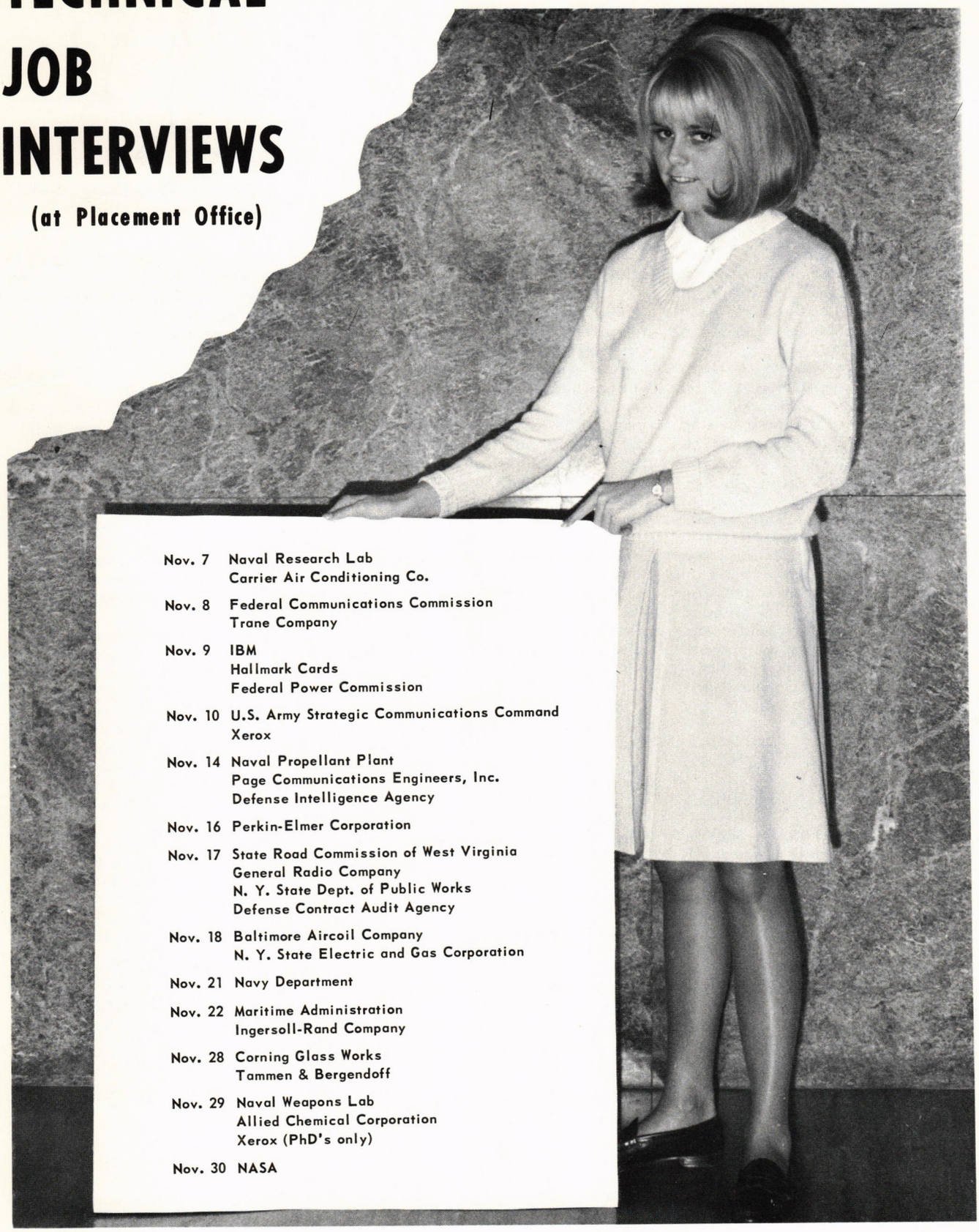
TECHNICAL JOB INTERVIEWS

(at Placement Office)



Nov. 7	Naval Research Lab Carrier Air Conditioning Co.
Nov. 8	Federal Communications Commission Trane Company
Nov. 9	IBM Hallmark Cards Federal Power Commission
Nov. 10	U.S. Army Strategic Communications Command Xerox
Nov. 14	Naval Propellant Plant Page Communications Engineers, Inc. Defense Intelligence Agency
Nov. 16	Perkin-Elmer Corporation
Nov. 17	State Road Commission of West Virginia General Radio Company N. Y. State Dept. of Public Works Defense Contract Audit Agency
Nov. 18	Baltimore Aircoil Company N. Y. State Electric and Gas Corporation
Nov. 21	Navy Department
Nov. 22	Maritime Administration Ingersoll-Rand Company
Nov. 28	Corning Glass Works Tammen & Bergendoff
Nov. 29	Naval Weapons Lab Allied Chemical Corporation Xerox (PhD's only)
Nov. 30	NASA

THE SHAFT

Three little children were sitting around talking one day about the most ferocious animals in the whole world. The first said "the most ferocious animal in the world is the alligator because he can bite you to little pieces." The second said "The hippo is the most ferocious animal in the world because he can mash you into little pieces." The third was the smartest of the bunch and he said, "No, you are both wrong, the meanest animal in the world is the hippigator because he has an alligator head on one end that can bite you into little pieces and a hippo head on the other end that can mash you into little pieces." The second then thought for a minute and asked, "If he has heads on both ends, how does he go to the bathroom?" To this the third answered, "He doesn't, that's why he is so mean."

* * *

Cannibal Chief--"What's for Lunch?"

Cook--"We have 1 engineering Professor."

Cannibal Chief--"Good, I'm in the mood for a Bologna sandwich."

* * *

Doctors bury their mistakes, Lawyers hang theirs, Engineers build monuments to theirs.

* * *

Once a King, always a King, but once a night is enough.

* * *

Probably the reason God made woman last was that he didn't want any advice while he was creating man.

* * *

The people in West Virginia claim that there aren't any idiots in the state. They say they vote every so often and send them to Washington, D. C.

* * *

Jack and Jill went up the hill,
Each one had a quarter.
Jill came down with fifty cents,
They didn't go after water.

Wench: Something to turn the head of a dolt.

* * *

Pants are made for men and not for women. Women are made for men and not for pants. When a man pants for a woman and a woman pants for a man, they are a pair of pants. Such pants do not always last and then they are called breeches of promise. This often turns into a suit. When two couples are mixed up in a suit, all panting, it is a suit with two pair of pants.

* * *

Professor of Economics: "You boys of today want to make too much money. Why, do you know what I was getting when I got married?"

Voice from rear: "No, and I'll bet you didn't either."

* * *

M.E.: "You once told me there was something about me you loved."

Sue: "There was, but we've spent it all."

* * *

They arrested her for soliciting, but she pleaded not guilty, claiming she was only calling her dog Tiz. . . . "Here Tiz, Here Tiz."

* * *

"My mother always told me to be good. . . . Was I?"

* * *

Cannibal King: "What am I having for lunch?"

Cook: "Two old maids."

Cannibal King: "Ugh! Leftovers."

* * *

MINUTE MAN: A fellow who double parks in front of a house of ill repute.

* * *

If her lips are on fire, and she trembles in your arms, give her up man . . . She probably has malaria.

* * *

Generally speaking, women are.

"I'm not the happiest person in the world, but I'm next to the happiest," murmured the supreme egotist as he took the sweet young thing into his arms.

* * *

"Cheer up, old man! There's other fish in the sea."

Rejected suitor: "Yes, but the last one took all my bait!"

* * *

The priest and the rabbi were sitting next to each other on the train, and as the trip continued, they struck up a conversation. As the friendship developed, the priest asked the rabbi if he would object to answering a rather personal question. The rabbi replied, "No."

"Well," the priest continued, "as part of your religion, you are forbidden to eat ham. True?"

"Yes, that's correct," replied the rabbi.

"Well, Sir," asked the priest, "have you ever eaten any ham?"

"Yes, I have, Father," answered the rabbi, "and would you mind if I ask YOU a personal question?"

"No, go ahead."

"As a priest, you are required to take a vow of celibacy. Have you ever broken that vow, Father?"

The priest hesitated for a moment and then replied, "Yes, once when I was much younger I did."

The rabbi thought for a moment and then commented, "Sure beats ham, doesn't it?"

* * *

Love is blind. That's why you see so many spectacles in the park.

* * *

In addition to the A.C.T. and math test, GW now has a new entrance exam. They send you to a magic show. If you sit there and take it all in, you pass. If you ask questions and try to figure it out, you can still come to GW but you can't major in physics.

It's a good system if you like it

There are slots.
Slots need people to fill them.
Someone exists who was born and educated to fill each slot.
Find him. Drop him in. Tell him how lucky he is. Look in once in a while to make sure he still fits his slot.

This orderly concept has much to commend it, plus one fault: some of the people most worth finding don't like it. Some very fine employers have not yet discovered the fault. It is not up to us to point it out to them. Luckily for us, we needn't be so tightly bound to the slot system.

We can offer *choice*. A certain combination of the factors diversification, size, centralization, and corporate philosophy makes it feasible to offer so much choice.

Choice at the outset. Choice later on. Choice between quiet persistence and the bold risks of the insistent innovator. Choice between theory and practice. Choice between work in the North and South. Choice between work wanted by the government and work wanted directly by families, by business, by education, by medicine, by science. To the extent that the slot idea helps channel choice we use it, of course.

A corporation such as this is one means of coordinating the strength of large numbers of effective persons. You may feel that in the years ahead this type of organization must change. You may feel that it must not change. Either way, to get a chance to steer you have to come on board.

Advice to electrical engineers, mechanical engineers, chemical engineers, chemists, and physicists—still on campus or as much as ten years past the academic procession: while one starts by filling a slot, it soon proves more fun to make one. No detailed list of openings appended herewith. Next week it would be different. G. C. Durkin is Director of Business and Technical Personnel, Eastman Kodak Company, Rochester, N. Y. 14650.

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